DTIC
S ELECTE D
JUL 3 0 1987
CD
D

Documentation of
Decision-Aiding Software:
R-SCREEN USERS MANUAL

Roy M. Gulick
Linda B. Allardyce

DECISIONS and DESIGNS, INC.
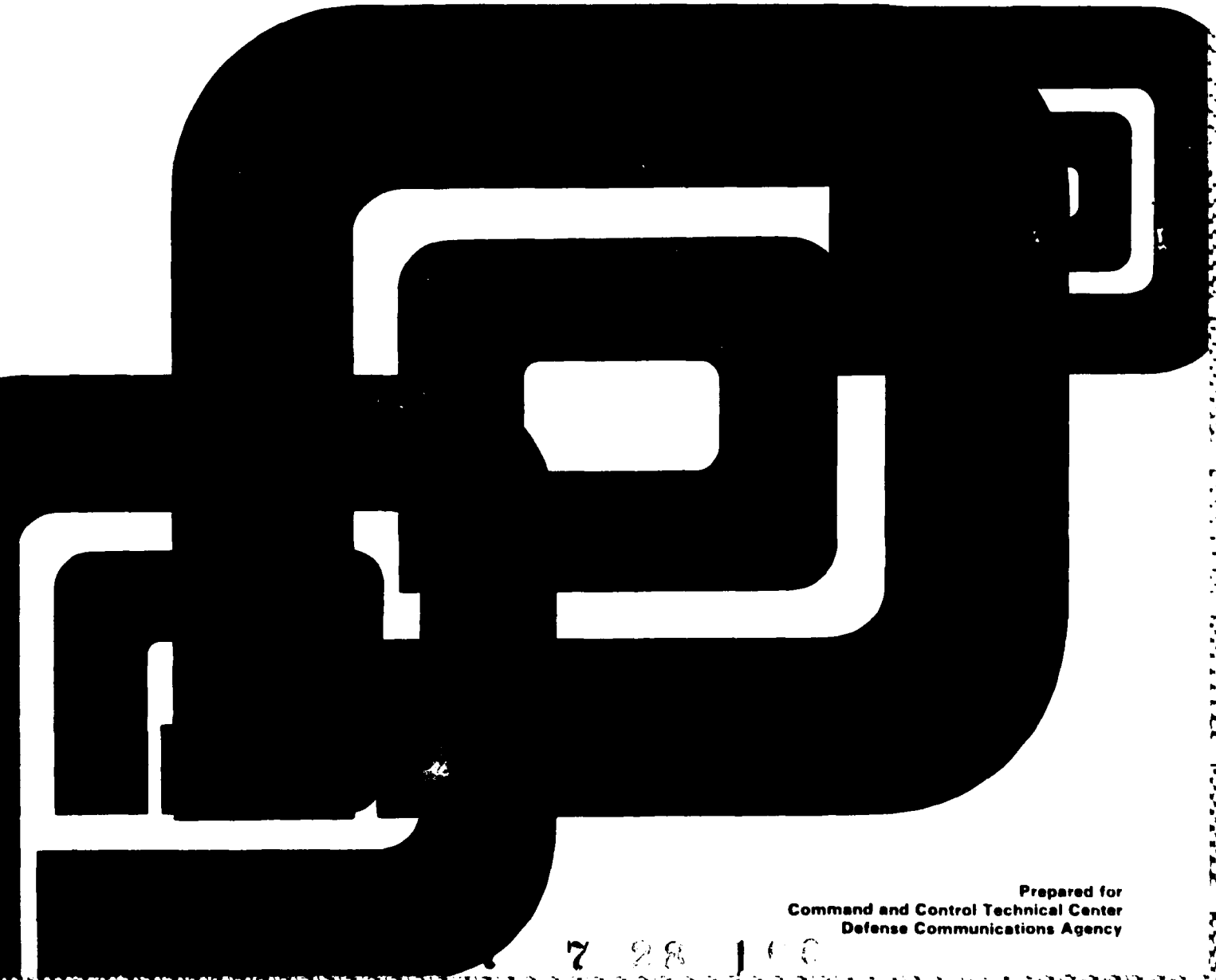
7 28 1

DOCUMENTATION OF DECISION-AIDING SOFTWARE:
R-SCREEN USERS MANUAL

by

Roy M. Gulick and Linda B. Allardyce

Sponsored by

October 1979
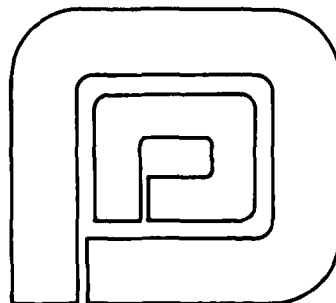
Accession For

NTIS CRA&I	✔
DTIC TAB	☐
Unannounced	☐
Justification	

By
Distribution/

Availability Codes

| Dist | Avail and/or special |

A-1

DECISIONS and DESIGNS, INC.

CONTENTS

CONTENTS

CONTENTS

FIGURES

1.0 INTRODUCTION

1.1 Purpose of the Users Manual

The purpose of this manual is to provide users of the R-SCREEN system with the background material and the detailed instructions necessary to use and interpret the various functions that R-SCREEN provides. The manual also presents the decision-analytic concepts inherent in the R-SCREEN approach, including the assumptions and restrictions concerning its use.

Because the manual must serve users both skilled and unskilled in the use of decision-analytic methodology, it is prepared in a modular fashion. Thus, whereas the initial sections provide detailed information for the more technically naive or casual user, the last section is direct and unelaborated for those users knowledgeable and skilled in the approach.

1.2 References

1.2.1 Barclay, Scott, et al. Handbook for Decision Analysis. Technical Report 77-6-30. McLean, Virginia: Decisions and Designs, September 1977.

1.2.2 Brown, R. V.; Kahr, A. S.; and Peterson, C. R. Decision Analysis for the Manager. New York: Holt, Rinehart, and Winston, 1974.

1.2.3   Lindley, D. <u>Making Decisions</u>. London: Wiley, 1971.

1.2.4   Raiffa, H. <u>Decision Analysis: Introductory Lectures on Choices Under Uncertainty</u>. Reading, Massachusetts: Addison-Wesley, 1968.

1.3 Terms

1.3.1 <u>R-SCREEN</u> - R-SCREEN is an abbreviation for Rapid Screening of Decision Options, reflecting the system's major area of applicability in the operations directorate of a large military staff.

1.3.2 <u>Decision analysis</u> - Decision analysis is an analytical methodology for helping individuals and organizations to make better decisions, principally by structuring the relationships among the various considerations, both objective and subjective, which enter into any decision. A complex decision problem is decomposed into clearly defined components, such as decision alternatives, uncertainties, and outcome values. The problem is then structured as a formal and dynamic decision model, typically implemented on an interactive computer-graphics terminal.

The outcome values are quantified in the light of the decision maker's personal perceptions; the uncertainties are assessed from available information and expert sources. Logical implications of the model for assessment, evaluation, prediction, and action are deduced, displayed, and incorporated into the decision-making process. The decision maker's attitude toward risk is explicitly accounted for in the analysis. When subjective values or data are used in conjunction with objective numbers, sensitivity analyses are used to validate the results. Such analyses

2

are easily performed in near real-time on an interactive
computer terminal.

The user is encouraged to consult the four
references for background material on decision analysis.

2.0 SYSTEM SUMMARY

2.1 Background

During crisis situations, military decision makers and
their staffs strive to react swiftly, decide wisely, and
communicate accurately. However, by its very definition, a
crisis situation imposes significant obstacles to the suc-
cessful attainment of those three worthwhile objectives.

Some of the obstacles occur because in a crisis situa-
tion decision makers and their staffs must necessarily
abandon their routine day-to-day working relationships,
information channels, and standard, familiar procedures.
Other obstacles arise from the increased tension and anxiety
introduced by the enormity of the stakes at hand and the
attendant uncertainties, risks, and intricate value trade-
offs. Still other obstacles stem from the inherent pressures
of time constraints and the ambiguity of goals and value
structures.

In addition, crisis decision making is usually attended
by extraordinary demands for and the production of infor-
mation. The tasks of information collection, processing,
and distribution may well dominate the workflow and unduly
monopolize the time and attention of the decision maker.
Indeed, crisis decision makers are often inundated with a
vast and diverse collection of information, both objective
and subjective. Both kinds of information may be of highly
varying quality and relevance.

The high premium usually placed on information collec-
tion and processing, coupled with the significant obstacles
imposed by the crisis situation, greatly enhance the always-
present opportunities for misperception, misunderstanding,

and miscommunication among decision makers and their staffs.
To prevent those opportunities from arising, decision makers
need effective decision strategies that impose rigor and
provide a logical, structural framework to assist them in
the process of choosing an optimal decision alternative in
the face of voluminous and often inconclusive evidence,
staff reports, expert opinion, and personal judgment.

R-SCREEN is a decision strategy that provides just such
a framework for deliberation, reasoning, and analysis.
R-SCREEN aids decision makers by prescribing a straight-
forward normative procedure for organizing and analyzing
difficult evaluation problems requiring the complex value
trade-offs pertaining to the ultimate choice of a course of
action.

R-SCREEN is an interactive computer software program
that permits the rapid evaluation of several different
courses of action. The program implements standard decision-
analytic procedures except that the more commonly used
decision tree structures are replaced by a simplified pre-
structured format called a Decision Template. The templating
procedure is a quick, accurate, and useful way of evaluating
courses of action. It is used to expedite the decision
analysis when the time available for it is very short; and
to identify the critical features of the problem for more
detailed analysis and hypothesis testing.

Each decision template encompasses the critical elements
of the political-military situation in much the same manner
as a well-developed contingency plan.

In fact, the R-SCREEN template should be thought of as
a sophisticated contingency plan that had been developed
ahead of time and which captures the lessons learned from
previously accumulated crisis management experience.

5

There are three fundamental steps involved in the R-SCREEN evaluation of decision options. First, the courses of action to be considered are selected; second, the relative value of each course of action is determined through a hierarchical decomposition assessment procedure; finally, the sensitivity of the results of the analysis to changes in the input values is examined.

Removing some of the complexity and detail of an actual problem description to fit the requirements of the basic R-SCREEN template entails some attendant loss of information. However, this streamlining process has the advantage of making the most important elements of the problem and their relationships to one another more easily understood and communicated to the decision maker. In each application of R-SCREEN, the user must judge whether the simplification which allows for more rapid analysis is so restrictive as to detract seriously from the final results. The primary advantage is that the process of using the R-SCREEN approach normally leads to a better understanding and more concise statement of the problem and a more rigorous and enlightening evaluation. Accordingly, the process of using the R-SCREEN template approach promotes better understanding of the problem and leads to a more concise problem definition. That, in turn, leads to a more coherent and insightful evaluation of the courses of action.

The fundamental product of R-SCREEN is a computer-stored evaluation model of the decision problem at hand. Whereas decision analysis provides the theoretical background and procedural guidance, the R-SCREEN evaluation model provides the specific methodological tool for processing relevant information and evaluating the various courses of action open to the decision maker.

2.2 Objective

R-SCREEN is a decision-analytic based, computer-assisted evaluation strategy. Its primary objective is to provide decision makers an explicit procedural framework, or evaluation template, that will ensure that their ultimate choice of a course of action is a coherent one: a choice fully consistent with their own value structures.

It must be emphasized that the use of decision analysis and R-SCREEN does not in any way replace human judgment; rather, the objective is to exercise and aid human judgment.

The R-SCREEN system provides decision makers with the capability to construct, store, retrieve, exercise, and modify evaluation models. The user who is inexperienced in techniques of decision analysis is cautioned that the R-SCREEN modeling procedure should not be applied indiscriminately, nor should its results be interpreted blindly. In particular, the prospective user must understand that the R-SCREEN evaluation framework fits only those decision situations that meet all of the following characteristics:

o A single decision is under consideration. That is, one course of action must be selected from among several candidates.

o The decision maker is working under a severe time constraint.

o A simple structural problem representation, in the form of an R-SCREEN template, will suffice.

o The decision problem is well formed; that is, the alternative courses of action have been clearly identified.

o   Multiple attributes, as specified by the R-SCREEN
     template, apply to the overall evaluation of the
     eventual outcome of the decision.

o   An ad hoc solution is appropriate.

2.3 Purpose of the R-SCREEN Model

At this point it must be noted that the purpose of an
evaluation model constructed using R-SCREEN is not to capture
reality, but rather to approximate it. Structuring an
evaluation model is more art than science, and the practice
of that art is attended by great difficulties in selecting a
representative set of viable courses of action and assigning
their respective merit across a set of selection criteria.
Ideally, an experienced professional decision analyst would
work closely with the decision maker and the staff in struc-
turing and using an evaluation model.

In any case, the ultimate tests of an evaluation model
should be:

a.   Is the model free of obvious inconsistencies?

b.   Does the model approximate the reality of the
     situation?

c.   Is the model practical and useful to the decision
     maker and the staff?

d.   Does use of the model provide additional insight
     into the decision problem?

2.4 Procedural Overview

The R-SCREEN procedure assumes that a decision problem exists and that alternative courses of action have been identified. The decision-making task is to evaluate the various alternative courses of action and select that one course that provides the greatest expected utility to the decision maker, consistent with the decision maker's expressed value structure, or criteria for success.

2.4.1 Template selection - The first step in using R-SCREEN is to select one of three distinct evaluation templates, each of which addresses one particular type of operational decision problem. The templates address the following problem areas:

1. projection of forces for political purposes;

2. posturing forces for possible evacuations; and

3. choosing among options involving significant risks.

The evaluation mechanism embedded in the three templates is one of hierarchical decomposition; that is, separating the overall evaluation task into several major parameters, or criteria, each of which is itself decomposed into its component elements, and so on in an explicit and logical fashion until a level of detail is reached at which one or more experts can make an informed and accurate assessment of the relative merit of each course of action.

The decomposition process focuses the evaluation process, permitting examination and analysis of one criterion

at a time. Conversely, the assessments made at the lowest
levels in the template structure can be weighted and aggre-
gated to produce a unique figure of merit, or overall value
of utility, for each proposed course of action.

The hierarchical structure of the three evalua-
tion templates is shown in Figures 2-1, 2-2 and 2-3. Note
that each template permits the inclusion of "other" criteria
at the user's option. Definitions of the various criteria
that comprise each structure are included within the R-
SCREEN model.

2.4.2 Assessing utilities - Once the user chooses a
particular template as representative of the decision
problem at hand, the user must assess the relative utility
of each course of action with respect to each of the lowest,
or bottom-level, criteria in the structure.

Utility is the standard measure for assessing a
degree of preference. A utility is a number between 0 and
100, inclusive, that represents the percentage of satisfac-
tion contributed by a particular course of action with
respect to any criterion in the R-SCREEN template. However,
the user assesses utilities only for the bottom-level cri-
teria. The utilities at the higher level nodes in the
structure are computed by R-SCREEN based on user inputs.

Because the evaluation process must discriminate
only among the specific proposed courses of action, the user
need only assess utilities relative to the specific courses
of action at hand. A relative utility assessment requires
that the best course of action always be assigned a value of
100 (complete satisfaction), and the worst always assigned 0
(no satisfaction). Appropriately scaled values of utility
are assigned to those courses of action that are neither
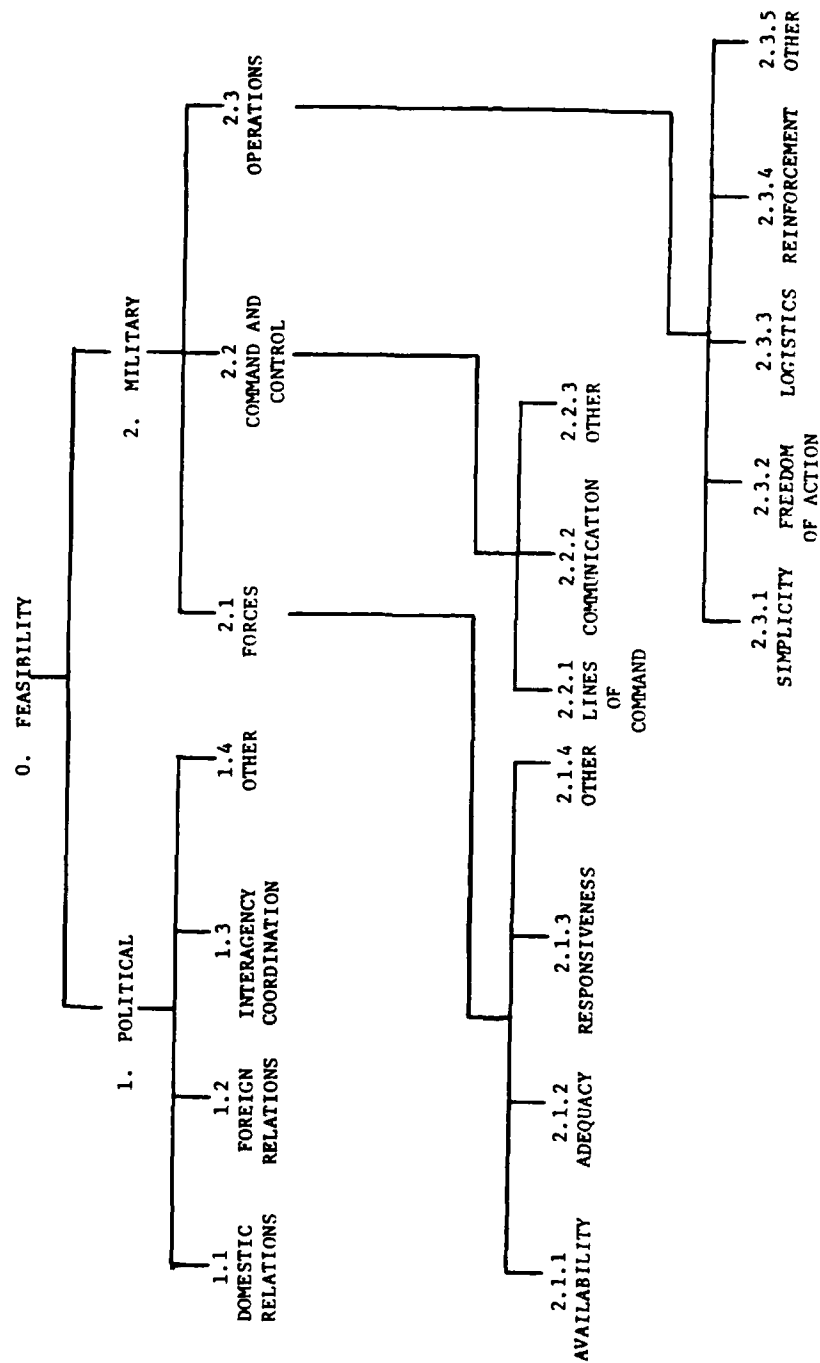
Figure 2-1

PROJECTION OF FORCES FOR POLITICAL PURPOSES
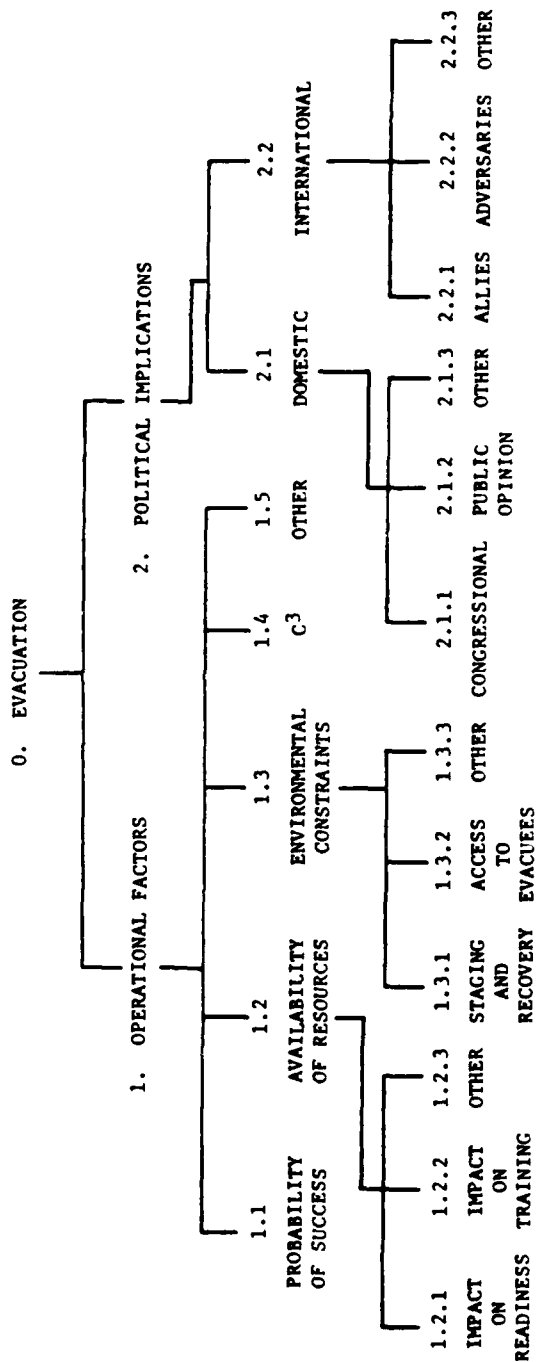
Figure 2-2

EVACUATION TEMPLATE
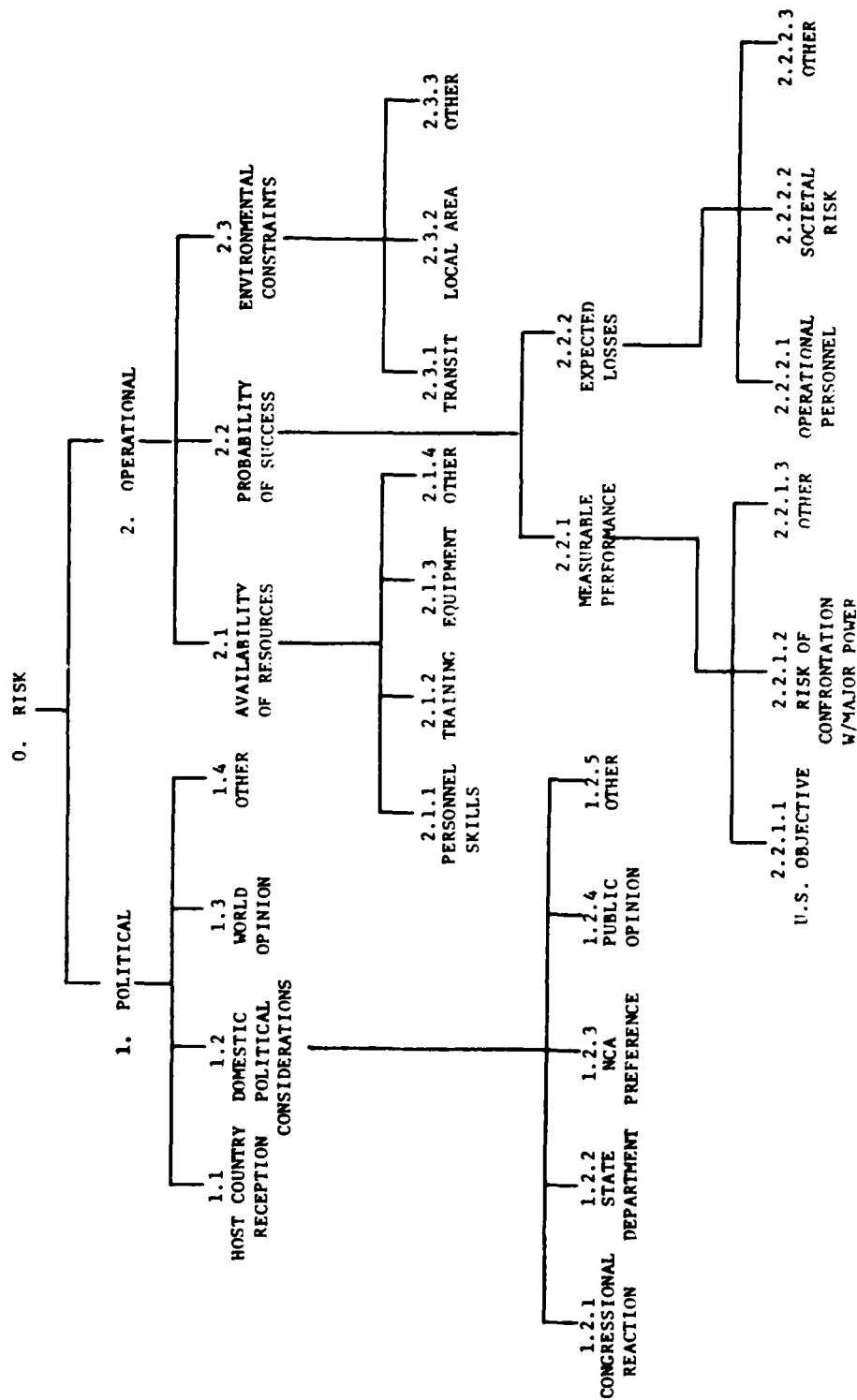
Figure 2-3

RISK TEMPLATE

best nor worst. A utility of 50, for example, implies that the course of action would provide a degree of satisfaction that falls about halfway between those provided by the best and worst courses of action.

Utility assessment is done only for the bottom-level criteria; R-SCREEN will automatically aggregate bottom-level utilities to form successively higher level utilities until a single overall utility is produced for each course of action. Written rationale must support the assessment of utilities for the bottom-level criteria.

2.4.3 <u>Assessing importance weights</u> - Once the user has assigned values of utility for the bottom-level criteria, the user must then assess the relative importance of the criteria.

For example, consider bottom-level nodes 2.2.1, 2.2.2, and 2.2.3 shown in Figure 2-1. Assuming that node 2.2.3 (Other) is not defined, the structure shows that the command and control criterion (2.2) is composed of lines of command (2.2.1) and communication (2.2.2). Once the user has assigned values of utility with respect to each bottom-level criterion (2.2.1 and 2.2.2), then the user must assess the relative importance of each to the next higher level criterion, command and control (2.2). The importance weights are expressed as percentages and must sum to 100; for example, a representative assignment is 40, 60.

Importance weights are determined by examining the relative impact of the difference between the best and worst courses of action with respect to the next higher level criterion. This process continues until importance weights are specified for all higher level criteria.

14

It must be clearly understood that the user is not being asked to provide an absolute, global assessment of the relative importance of the criteria. Continuing the above example, for instance, the user is not being asked to weigh the relative importance of having good lines of command (2.2.1) versus having good communications (2.2.2). Rather, the user must restrict attention to the particular courses of action being evaluated. For each criterion being compared, the user must visualize the best course of action and the worst course of action and focus on the significance of that difference. Finally, the user must assess the overall relative impact on command and control (2.2) of having to implement the worst vice the best course of action with respect to lines of command (2.2.1) versus having to implement the worst vice the best course of action with respect to communications (2.2.2). If for a given criterion the difference in impact between the best and the worst courses of action is virtually insignificant, then that criterion should have no importance weight at all; it simply does not discriminate. If, on the other hand, the impact of implementing the worst course of action vice the best is monumental then that criterion should be heavily weighted.

2.4.4 <u>Results</u> - Once the utilities and relative importance weights have been specified by the user, R-SCREEN can compute the overall utility of each of the various courses of action, as well as its utility with respect to any designated criterion. In addition, R-SCREEN can produce a variety of sensitivity analyses, as described in Section 3.0.

2.5 <u>Summary</u>

One of the greatest advantages of the R-SCREEN templating procedure is in the area of facilitating communication among different staff elements. Staff personnel will not

only know precisely where they disagree but by how much and what difference it might make. This enhanced communication among the staff facilitates staff integration and reduces the likelihood of critical misunderstandings. In addition, by organizing the dialogue and debate among the crisis management team members, it substantially speeds up the process of developing a recommendation so that the staff is not overtaken by events. Furthermore, the process preserves the rationale supporting the choice of a course of action.

In summary, templating is a formal procedure for structuring those judgments which would normally be made anyway by the staff in times of crisis. It requires that the staff identify alternative courses of action, that they describe the consequences associated with each course of action, that they identify specific criteria against which those consequences can be evaluated, and that they encode those consequences numerically so that sensitivity analyses can be carried out to develop a sound recommended course of action. While some of the steps can be carried out intuitively or using pencil and paper, the implementation of the templating procedure using R-SCREEN provides several real advantages. For example, use of the computer permits the calculations necessary to evaluate each possible course of action to be repeated many times to test, at the direction of the user, the effect of changes in the input data. In addition, the computer program acts as a recording device as the decision problem is structured, by keeping track of and displaying the lists of options, criteria, definitions, rationale, and value dimensions. R-SCREEN also facilitates the development of the problem structure.

3.0 STRUCTURING AN R-SCREEN MODEL

R-SCREEN permits the user to create a computer-stored library of different evaluation models. Each model is unique to a particular evaluation problem. The models are all identified by the name of the problem, the name of the person who created the model, and the date of creation.

As described in Section 5.0, the user may build and exercise new models and then add them to the library or retrieve and exercise old models. Each R-SCREEN model consists of the following elements.

3.1 A Problem Name

The user must provide a concise name for the decision problem at hand. The name serves to uniquely identify the model for storage and retrieval by the R-SCREEN system.

3.2 Courses of Action

The user must create a list of the specific viable courses of action that are available to the decision maker. These are several guidelines that pertain to the creation of that list.

a. The list should be exhaustive. That is, it should include all of the alternatives that are under serious consideration. A key assumption here is that one of the alternatives on the list will in fact be chosen. In that regard, note that a course of action "not to decide yet" (to buy additional time or to purchase additional information, perhaps) is a perfectly legitimate alternative for inclusion on the list.

b. The list should be exclusive; that is, the alternatives should be independent. The selection of one alternative should preclude the implied selection of another. That restriction, together with the previous one, ensures that one and only one of the alternative courses of action will ultimately be chosen.

c. The alternatives on the list should be reasonable ones. The list should not include any alternatives that are impossible to implement (because of time and space factors, for example) or that, although possible, are so impracticable that they would never be selected under any circumstance.

d. Similar courses of action should be combined where possible in order to reduce the total number of choices to a reasonable length. Six alternatives is an upper bound; three or four are preferred.

e. At this point the short, refined list of decision alternatives should pose a true dilemma for the decision maker. Each one of the alternatives should have a strong appeal to the decision maker on at least one dimension of value. If not, if any alternative seems to have nothing at all to recommend it, that alternative should be removed from the list.

3.3 Evaluation Template

Considering the nature of the problem at hand, the user must next choose one of the three evaluation templates shown in Figures 2-1, 2-2, and 2-3. Furthermore, the user should refine the template so that it best approximates the problem environment.

There are two ways to refine the template: by using
the nodes marked "Other" to represent additional criteria,
and by using the editing feature of R-SCREEN to modify the
criteria labels as appropriate. That is, the user may
change the names and definitions of any of the criteria to
suit the evaluation at hand.

3.4 Criteria Definitions

The user should carefully review all of the criteria
definitions and modify them as appropriate. This is done
interactively by using the editing feature of R-SCREEN to
change the criteria labels and criteria definitions as
appropriate.

3.5 Utility of the Courses of Action

For each bottom-level criterion, the user must specify
the most-preferred and the least-preferred courses of action.
The most preferred is always assigned a utility of 100 ; the
least preferred is always assigned a utility of 0. Inter-
mediate values of utility are assigned to the remaining
courses of action as described in Section 2.4.2.

3.6 Rationale for Utility Assessments

The user should provide concise written rationale to
support the utility assessments. That is done interactively.

3.7 Criteria Importance Weights

For each higher level criterion, the user must assess
and specify the relative percentage of importance of its
lower level components. This is done on a bottom-to-top
basis, as described in Section 2.4.3.

3.8   Rationale for Criteria Weights

The user should provide concise written rationale to support the assignment of criteria weights. This is done interactively for all criteria except those at the bottom level.

This completes the model format. An R-SCREEN evaluation model is completely and uniquely specified when the elements described above are specified by the user.

4.0 RESULTS OF THE MODEL

Once an R-SCREEN model has been completely defined by the user (by specifying utilities and importance weights), R-SCREEN provides several results in three different categories: final results, sensitivity analyses, and rankings.

4.1 Final Results

There are three kinds of final results. All are available under the DISPLAY menu option. The sample displays appearing in this section of the manual are based on the feasibility template, Figure 2-1.

4.1.1 Matrices - For any desired criterion, the user can display the final aggregate value of utility associated with the various courses of action. A result matrix is requested by specifying the criterion number. Figure 4-1 shows a matrix for criterion 1--POLITICAL. Note that the display includes the various factors (immediate lower level criteria) that together comprise the criterion being displayed and their relative contribution to the higher level criterion in question, as shown in parentheses. For example, interagency coordination constitutes only 5% of the political criterion An asterisk to the left of the WT column indicates that that factor (e.g., Foreign Relations) is a bottom-level criterion. The CUMWT column indicates each criterion's contribution to the entire evaluation process. In the example, Foreign Relations considerations account for 9% of the entire evaluation of the courses of action.

The user should also note that, with respect to political considerations only, course of action #2 provides the greatest utility, 82% satisfaction, with courses of action #1 and #3 providing 58% and 13% respectively.

21

The final overall evaluation of the courses of action is obtained by displaying the matrix for the highest level criterion: 0--FEASIBILITY.

    CA1: TAKE NO ACTION. AWAIT FURTHER DEVELOPMENTS.
    CA2: COMPLAIN IN U.N. WARN USSR AND RAMBO.
    CA3: CONDUCT NIGHT RAID. DESTROY OFFENSIVE WEAPONS.

1   POLITICAL

--FACTOR--	WT	CA1	CA2	CA3	CUMWT
1) DOMESTIC RELATIONS	*(53)	100	70	0	14.5
2) FOREIGN RELATIONS	*(42)	0	100	30	9.0
3) INTERAGENCY COORD	*(5)	100	50	0	1.1
--TOTAL--		58	82	13	24.6

Figure 4-1

MATRIX DISPLAY

4.1.2 **Definitions** - Definitions of the various criteria that comprise the final evaluation structure. A definition is requested by specifying the identification number of the desired criterion preceded by the letter D. For example, the user would type D1.1 to display the definition of criterion 1.1--DOMESTIC RELATIONS. The result is shown in Figure 4-2. Note that the definition should reflect the particular considerations that characterize the decision problem at hand. That is, definitions should be altered by the user to fit the situation.

4.1.3 **Rationale** - Rationale that supports both the final assignment of utility scores to the decision options with respect to the bottom-level attributes and the final assignment of criterion importance weights. Rationale is requested by specifying the criterion identification number preceded by the letter R. For example, the user would type

22

1.1 - DOMESTIC RELATIONS

    The impact that the course of action has on U.S.
  1] domestic policy; on Congress, the judicial branch, the
  2] media, domestic interest groups, and the public at large.
  3]
  4]
  5] o BEST CASE -- The course of action is in total
  6] harmony with and supportive of U.S. domestic policy.
  7]
  8] o WORST CASE -- The course of action is in total
  9] conflict with and disruptive of U.S. domestic policy.
 10]

.n   - moves cursor to line n
.s(ave) - stores definitions on disc

Figure 4-2

ATTRIBUTE DEFINITION DISPLAY

23

R1.1 to display the rationale that supports the assignment of utility scores to the bottom-level criterion 1.1--DOMESTIC RELATIONS. Figure 4-3 shows a typical result. Note that rationale can occupy two pages of text, as shown in the figure. Entry of rationale is covered in Section 5.2.1.

4.2 Sensitivity Analyses

There are two kinds of sensitivity analyses available to the user: SWING WEIGHTS and NEXT BEST. Both are available under the SENSITIVITY menu option.

4.2.1 Swing weights - The SWING WEIGHT analysis displays the sensitivity of the preferred course of action to variations in the cumulative importance weight assigned to any criterion. The user selects a criterion and specifies the minimum and maximum allowable cumulative weights. R-SCREEN then varies the cumulative weight from the minimum to the maximum value in uniform intervals and displays the associated overall total utility for each course of action. For each value of importance weight, the course of action having the greatest utility is identified with an asterisk. A sample display is shown in Figure 4-4.

The other criteria maintain their correct proportional relationships as the weight of the criterion being examined varies through its specified range.

4.2.2 Next best - The NEXT BEST sensitivity analysis also displays the sensitivity of the preferred course of action to a variation in the weight assigned to any criterion. However, it displays the amount by which the cumulative weight of each of the factors that comprise that criterion would have to change in order to cause the previously overall second-best course of action to become the best

24

1.1 - DOMESTIC RELATIONS   CA1 CA2 CA3
                              100   70   0   PAGE 1

1] On the domestic front, the climate is such that an
2] overt action would create confusion and uproar in
3] both the Congress and the public sector. The situation
4] would prove intolerable should there be no missiles
5] found in Rambo.
6]
7] The second course of action, warn, would generate some
8] domestic furor, but the White House staff feels that
9] a strong U.N. speech against Rambo would arouse domestic
10] support.

.n   - moves cursor to line n
.s(ave) - stores rationale on disc
.p(age) - gets next page

Figure 4-3
RATIONALE DISPLAY

25

1.1 - DOMESTIC RELATIONS   CA1 CA2 CA3
                                  100   70   0   PAGE 2

1] The preferred course of action is to await further
2] developments. However, that could change because
3] the media have picked up on our lack of action
4] against the Rambo threats to our bases and aircraft.
5]
6] The domestic relations situation is dynamic and must
7] be monitored on a daily basis.
8]
9]
10]

.n   - moves cursor to line n
.s(ave) - stores rationale on disc
.p(age) - gets next page

Figure 4-3 (continued)
RATIONALE DISPLAY

26

2.2 - COMMAND AND CONTROL   CURRENT CUMWT: 11.5

THE MINIMUM CUMWT IS?: 5
THE MAXIMUM CUMWT IS?: 30

2.2 - COMMAND AND CONTROL   CURRENT CUMWT: 11.5

WT	CA1	CA2	CA3
5.0	56	74*	70
7.5	57	72*	70
10.0	58	70*	69
12.5	60	68	69*
15.0	61	67	68*
17.5	62	65	67*
20.0	64	63	66*
22.5	65	60	66*
25.0	66*	58	65
27.5	68*	56	64
30.0	69*	55	64

Figure 4-4

SWING WEIGHT SENSITIVITY ANALYSIS

course of action with respect to that criterion only. This
feature is normally used only for the top-level criterion;
it may, however, be used to examine any criterion of interest.

A sample output display is shown in Figure 4-5.

2   MILITARY
    1) FORCES
    2) COMMAND AND CONTROL
    3) OPERATIONS

FACTOR	(1)	(2)	(3)	TOTAL	BEST CA
CUR CUMWTS	10.80	12.61	15.34	38.75	CA2
EQL CUMWTS	14.01	9.72	15.02	38.75	CA1

Figure 4-5

NEXT BEST SENSITIVITY ANALYSIS

The figure shows that the criterion MILITARY has a cumulative weight of 38.75 spread among three factors: FORCES, COMMAND AND CONTROL, and OPERATIONS. The current cumulative weight of each factor is shown, and the current best course of action with respect to the MILITARY criterion is CA2. If the weights of all three criteria were changed to those shown under EQL CUMWTS, then CA1 would become the best course of action under the MILITARY criterion. That is, if FORCES were to become more important and the other two factors were correspondingly less important in the amounts shown, then the previously next-best course of action (CA1) would be preferred.

Both of the sensitivity analyses should be used to check the overall consistency of the final results.

4.3 Rank

The user can rank order the criteria comprising the evaluation in three different ways: by their cumulative weights, by pro-con support for the preferred course of action, and by their correlation with the overall utility scores of the courses of action. All three rankings are available under the PRINT menu option.

4.3.1 Cumulative weights ranking - The user can display the bottom-level criteria ordered by their cumulative weights. This ranking identifies the most important and least important criteria in the evaluation. It should be used to check the consistency of the evaluation structure. A sample display is shown in Figure 4-6.

4.3.2 Pro-Con ranking - The user can display the bottom-level criteria ordered by the degree to which they

28

support the overall best course of action over the second-best course of action. A sample display is shown in Figure 4-7.

FACTORS RANK ORDERED BY CUMWT

FACTOR		CA1	CA2	CA3	CUMWT
1.1	DOMESTIC RELATIONS	100	60	0	10.3
2.1.1	AVAILABILITY	0	75	100	9.2
2.3.1	SIMPLICITY	0	20	100	7.2
.	--etc--				.
2.3.4	REINFORCEMENT	50	0	100	2.4
1.2	FOREIGN RELATIONS	80	100	0	2.1

Figure 4-6

CUMULATIVE WEIGHTS RANKING

FACTORS RANK ORDERED BY BEST CA VS. SECOND BEST CA

CA1: 56
CA2: 44
CA3: 52

FACTOR	BEST CA	NEXT CA	CUMWT	DIFF
FREEDOM OF ACTION	100	10	8.7	8
AVAILABILITY	100	0	6.2	6
LOGISTICS	90	0	5.8	5
.				.
.				.
.				.
FOREIGN RELATIONS	0	100	4.2	-4
RESPONSIVENESS	0	100	6.0	-6

Figure 4-7

PRO-CON RANKING

The difference column indicates the amount of the attribute's relative support for the best course of action. A negative difference indicates that the attribute favors the next-best course of action.

4.3.3 <u>Correlation ranking</u> - The user can display a list that indicates the degree to which each bottom-level criterion supports the final results. The degree of support is expressed as a correlation coefficient ranging from 1.0 (completely correlated) to 0 (no correlation) to -1.0 (completely correlated, but negatively).

Complete correlation (1.0) with the final results implies that the criterion in question can be used by itself as a surrogate evaluation structure; the criterion predicts the final results. It discriminates among the courses of action in exactly the same way as does the total evaluation structure. The results are identical.

Zero correlation implies that the criterion in question reveals no information concerning the final results.

Complete negative correlation (-1.0) implies that the criterion in question can be used by itself as a surrogate for the total structure. The results it predicts, however, are exactly reversed from the results produced by the total structure. That is, the attribute favors the worst course of action.

The correlation ranking has the format shown in Figure 4-8.

30

FACTORS RANK ORDERED BY OVERALL SCORE

FACTOR		CA1	CA2	CA3	CUMWT	CORR
2.1.3	RESPONSIVENESS	100	50	0	10.4	.98
1.2	FOREIGN RELATIONS	100	65	0	7.9	.90
2.2.2	COMMUNICATION	100	0	20	6.8	.72
	.					
	.					
	.					
1.1	DOMESTIC RELATIONS	0	40	100	4.1	-.88
2.2.1	LINES OF COMMAND	0	50	100	9.8	-.97

Figure 4-8

CORRELATION RANKINGS

5.0   TECHNICAL OPERATIONS

This section explains how a user interfaces with the R-SCREEN software.

The first step is to select and load into the computer one of three magnetic disks.   Each disk corresponds to one of the three templates shown in Figures 2-1, 2-2, and 2-3; that is, there is a projection of force disk, an evacuation disk, and a risk disk.   The user inserts the disk into the disk reader and loads the contents into the computer by typing)LOAD RUN.

The operationaⅼ procedures described below are outlined in graphical form in Figure 5-1.   The user is cautioned to follow carefully the instructions given by R-SCREEN.   Once a process has begun it must be continued to completion.

5.1   The Preliminary Menu

Once the software is loaded, R-SCREEN displays a preliminary menu with two options.   The user must select one of the following options:

o   CREATE A NEW MODEL
o   LOAD AN EXISTING MODEL

Each option is described below.

5.1.1   Create a new model - This option is selected when the user is developing a completely new model.   R-SCREEN elicits descriptive material concerning the nature of the problem, the date, the user's name, and the number of different courses of action to be evaluated.   The user must also
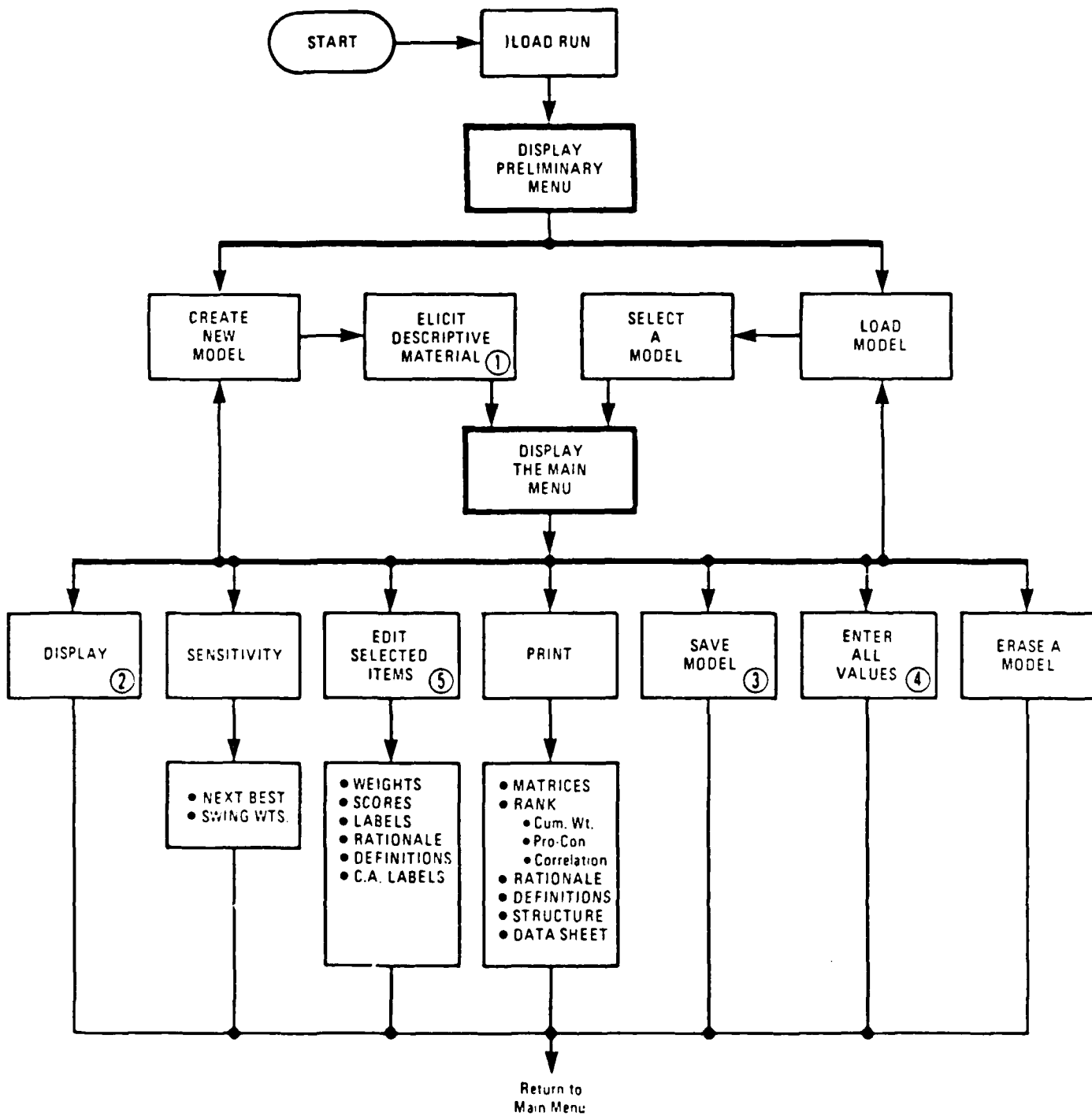
Figure 5-1

R-SCREEN FLOW LOGIC

define each course of action. R-SCREEN accepts up to eight courses of action.

Note that R-SCREEN does not ask the user for utility scores or attribute weights at this time. Those are elicited later, under the main menu option: ENTER ALL VALUES.

The user can also modify the template structure itself by changing the name of any criterion (including OTHER) and its definition. Those changes are made by using the EDIT SELECTED ITEMS menu option described later in Section 5.2.2.

5.1.2 Load an existing model - This option is selected when the user is reviewing or editing a model that was created during a previous R-SCREEN session. R-SCREEN displays a list of the models that it currently stores and asks the user to select one of them.

5.2 The Main Menu

The main menu contains nine options, as indicated in Figure 5-1. Two of them, CREATE A NEW MODEL and LOAD AN EXISTING MODEL have already been described. Those two options would be selected from the main menu at this time only if the user had finished working a particular model and desired to create or load another model.

Each of the remaining seven menu options is described below. The options are described in the logical order in which a user would normally use them when creating a new model.

5.2.1 <u>Enter all values</u> - Having described the struc-
ture of the new model tc be created, the user specifies the
utilities of the courses of action and the importance weights
of the criteria by selecting this menu option.

The elicitation procedure is automated. Figure 5-2
shows the procedure by which R-SCREEN elicits the utility
scores from the user. Figure 5-3 shows the procedure used
to elicit attribute weights.

Before entering all of the utility values, the
user may desire to use a work sheet to prepare the scores
manually. Note that R-SCREEN provides such a work sheet,
referred to as a data sheet, under the PRINT menu option
discussed in Section 5.2.3.

When entering utility values, the user may
encounter some difficulty with the meaning of the various
criteria. Should that happen, the user can display the
definitions of the criteria (and change the definition if
appropriate) by typing a question mark when the display
"WHICH CA IS BEST IN RESPECT TO..." appears.

R-SCREEN also solicits optional supporting
rationale from the user during the elicitation processes.
Up to two pages of free-form text can be entered.

It is important to note that special data entry
procedures are required when the user changes criteria or
enters rationale. R-SCREEN will display ten lines for data
entry. Each line has a line number enclosed in brackets, as
shown in Figures 4-2 and 4-3. The user may enter any desired
text, using both upper-case and lower-case letters. The
execute button is used to move to the next sequential line.
Special control commands apply, as indicated on the display:

35

1 POLITICAL
1.1 DOMESTIC   RELATIONS

CA1: TAKE NO ACTION.   AWAIT FURTHER DEVELOPMENTS.
CA2: COMPLAIN IN U.N. WARN USSR AND RAMBO.
CA3: CONDUCT NIGHT RAID.   DESTROY OFFENSIVE WEAPONS.

INDICATE THE RELATIVE POSITION OF THE REMAINING CA's.

```
   0    20   40   60   80  100
   |----|----|----|----|----|
   |              |         |
   3              2
```

THE SCORES ASSIGNED ARE 100 70 0
ARE THESE CORRECT? Y

Figure 5-2

ELICITING UTILITY SCORES

36

```
 1                  2                  3
 DOMESTIC           FOREIGN            INTERAGENCY
 RELATIONS          RELATIONS          COORDINATION

BEST   WAIT         WARN               WAIT

WRST   RAID         WAIT               RAID

ENTER RELATIVE WEIGHT FOR FACTORS 3 2 1

0        20        40        60        80        100
|----|----|----|----|----|----|----|----|----|----|
     3                            2

THE NORMALIZED WEIGHTS FOR (3 2 1) ARE:   5   42   53
ARE THESE CORRECT?
```
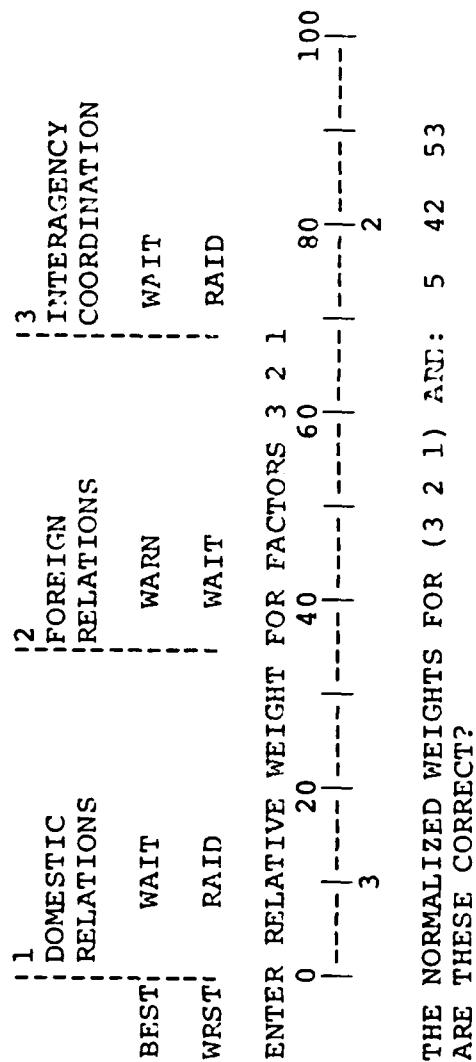
Figure 5-3

ELICITING ATTRIBUTE WEIGHTS

.s, .n, and .p. Those commands, a period followed by a character, when typed as the first two characters on any line, operate as follows. To return to the main program, type .s (save); to move to line number n of the text, type .n (line number); and to move to another page of text, type .p (page).

5.2.2 <u>Edit selected items</u> - Having entered the utility values and importance weights for a new model or loaded an old model, the user may change elements of the model by the EDIT MENU option. As shown in Figure 5-1, the user can change virtually all of the parts of the model: the criteria weights, utility scores, and supporting rationale. The user can also modify the basic structure of the model by changing the names of the criteria themselves (LABELS and DEFINITIONS) and the names of the various courses of action (C.A. LABELS) under consideration.

5.2.3 <u>Print</u> - The user can cause R-SCREEN to print out a wide variety of information, as indicated in Figure 5-1.

The complete structural representation of the model can be printed by using the STRUCTURE option. The output includes the assigned utility scores and criteria weights.

All of the criteria definitions and all of the rationale supporting the assignment of scores and weights can be printed by using the DEFINITIONS and RATIONALE options.

All of the result matrices, as described in Section 4.1.3, can be printed out by using the MATRIX option.

The three kinds of rank orderings described in Section 4.3 can be printed out by using the RANK option.

Finally, a work sheet, as discussed in Section 5.2.1, can be printed by using the DATA SHEET option.

The user may also pring the contents of the display screen at any time by holding down the COMMAND key and simultaneously pushing the X key that is directly under the COPY DISPLAY function listed at the top right of the keyboard.

5.2.4 Display - The DISPLAY option causes several final results to be displayed. The user can display the matrices, definitions, and rationale discussed in Section 4.1.

5.2.5 Sensitivity - This menu option performs the various sensitivity analyses described in Section 4.2.

5.2.6 Save model - Having created a new model or edited an old model, the user should ordinarily save the model for future recall. That is done by using the SAVE MODEL option.

To save a model the user must first specify an appropriate model name for identification purposes. To replace an existing model with a revised version of the model, the user simply specifies the name of the existing model when storing the revised model.

It is suggested that the user save a partially completed model at convenient steps toward its completion. Saving the model may prevent a considerable loss of time spent recreating the model should there be an unanticipated interruption or power failure.

5.2.7 Erase model - This option is used to remove an existing model from storage, thereby creating additional storage space for new models. Up to eight models may be stored at any one time.

6.0 ABRIDGED USERS MANUAL

This section provides unelaborated instructions for using R-SCREEN. It describes the sequential steps necessary to create a new R-SCREEN evaluation model, revise an existing model, obtain the results of a model, and save a model. Checklists for performing each operation are included.

6.1 Creating a New Model

To create a new model, the user must first select the appropriate evaluation template as shown in Figures 2-1, 2-2, and 2-3. Having chosen a template, the user must load the corresponding magnetic disk into the computer by inserting the disk into the disk drive and typing:)LOAD RUN.

R-SCREEN will immediately ask the user to select one of two options: to create a new model or to load an existing model. The user must choose the create new model option.

R-SCREEN will then ask the user to provide identification data and to specify the number of alternative courses of action and an appropriate designation for each. R-SCREEN will then display the main menu, as shown graphically in Figure 5-1.

The user may choose the EDIT menu option to change the template criteria labels and definitions to reflect the nature of the problem at hand.

The user may also choose the PRINT option to print out a data sheet to be used manually to record the utility scores for the bottom-level criteria.

The user must next enter the utility scores for each course of action for each bottom-level criterion. R-SCREEN will also elicit the criteria importance weights. The user enters the utilities and importance weights by selecting the ENTER ALL VALUES menu option. At the conclusion of entering the values, the user may revise values by using the EDIT option, if a revision is necessary.

At this point, the user would normally display the results of the model just created. The procedure for displaying results is described in Section 6.3.

6.2 Loading an Existing Model

To load an existing model, the user must select the magnetic disk on which the model is stored and load it into the computer by typing)LOAD RUN.

R-SCREEN will immediately ask the user to select one of two options: to create a new model or to load an existing model. The user must choose the second option. R-SCREEN will then display the names of these models stored on the disk. The user selects the desired model, which R-SCREEN will load into the computer's memory.

At this point, R-SCREEN displays the main menu of options, as shown graphically in Figure 5-1. The user may choose either to revise the model using the EDIT menu option, or to display the results of the model, as described below.

6.3 Displaying Results

Several results may be obtained using three different menu options.

41

6.3.1 _Display_ - The DISPLAY menu option produces a utility matrix for any desired criterion. To display a matrix, the user enters the identifying number of the criterion of interest, for example, 2.2.1. The user may also display the criterion definitions by preceding the identification number with the letter D, for example, D2.2.1. The user may display the supporting rationale by preceding the identification number with the letter R, for example, R2.2.1.

6.3.2 _Print_ - The user may print out the entire structure and specification of the model by choosing the STRUCTURE menu option. All utility matrices, definitions, and rationale can be printed as well by selecting the MATRICES, DEFINITIONS, and RATIONALE options, respectively.

R-SCREEN also provides lists of the criteria ranked in order of their cumulative importance weights, their correlation with the final results, and their degree of support for the best course of action over the next-best course of action. The user requests those lists by selecting the CUMWT, CORRELATION, and PRO-CON menu options, respectively.

6.3.3 _Sensitivity analyses_ - Two sensitivity analyses are available to the user by selecting the SENSITIVITY menu option. The swing weight analysis shows the sensitivity of the overall evaluation results to changes in the importance weight assigned to any specified criterion. The next-best analysis identifies the changes in importance weights that are necessary to make the previously second-best course of action become the preferred choice.

6.4 _Saving an R-SCREEN Model_

A newly created model or a revised older model must be saved or it will be lost forever. A model is saved by

storing it on the magnetic disk by using the SAVE MODEL menu
option.

Once SAVE MODEL is selected, R-SCREEN will request the
name under which the model should be stored. If the name
entered by the user is identical to that of another stored
model, the user will be so informed and given the opportunity
to change the name. If the user wants to replace an existing
model with a revised version, then the new model should be
stored under the same name, thereby automatically erasing
the previous version.

6.5 Checklists

Checklists for creating a model, revising an existing
model, obtaining the results of a model, and saving a model
are listed below.

6.5.1 Creating a new model –

o Load the appropriate disk.

o Select the CREATE NEW MODEL option.

o Select the EDIT MODEL option to change cri-
terion labels and definitions.

o Select the PRINT option to produce a data
sheet for recording scores manually.

o Select the ENTER ALL VALUES option to enter
utility scores and importance weights.

o Select the EDIT MODEL option to revise the
model.

o Display results, as described below.

6.5.2 Loading an existing model -

o Load the appropriate disk.

o Select the LOAD EXISTING MODEL option.

o Select the desired model.

o Select the EDIT MODEL option to make revisions to the model.

o Display results, as described below.

6.5.3 Displaying results -

o Create a new model or load an existing model, as described above.

o Select the DISPLAY option to display matrices, definitions, and rationale.

o Select the PRINT option, followed by:

- the STRUCTURE option to produce the entire structure and specification of the model;

- the RANK option to produce lists of the criteria ranked by their weight, correlation, and pro-con support for the best course of action vice the next-best.

o Select the SENSITIVITY option to produce a swing weight analysis and a next-best analysis.

o Save the model, as described below.

44

6.5.4 <u>Saving a model</u> -

o Select the SAVE MODEL option.

o Specify the name under which to store the
   model.

END

9-87

DTIC